South Australia Virtual Power Plant Phase 3A

Knowledge Sharing Report

Millstone 2 — Deployment of 500 Systems

ARENA Summary

Activity Title	South Australia Virtual Power Plant Phase 3A
Recipient	Tesla Motors Australia Pty. Ltd. (Tesla)
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Tesla Contact	Emma Fagan

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Executive Summary

Tesla Motors Australia, Pty. Ltd. (Tesla) is pleased to release the first milestone report of Phase 3A of our flagship virtual power plant (VPP) project, the South Australia Virtual Power Plant (SAVPP). This report is provided following the installation of the first 500 Phase 3A systems on SA Housing Authority (SAHA) properties in South Australia.

A VPP is a network of distributed energy resources – such as residential properties with solar and battery systems – working together as a single power plant. The SAVPP provides SAHA tenants with reduced electricity rates by maximising the market revenues of the VPP. Tesla have developed sophisticated software to orchestrate the output of VPP systems exporting to energy markets when prices are high, importing during periods of excess solar generation and aggregating systems to provide critical system security services. The SAVPP will comprise of up to 50,000 solar and Tesla Powerwall home battery systems across public and private residences in South Australia, forming Australia's largest VPP, and is being deployed in distinct Phases.

- Phase 1, completed in June 2018 features 100 systems installed across South Australia Housing Authority (SAHA) properties and demonstrated the technical capability of the systems to operate as a VPP, while supporting the development of Tesla software

- Phase 2 was completed in December 2019 and features 1,000 systems installed across SAHA properties provided at no upfront cost, with customers given a market leading retail electricity offer. Phase 2 assets are registered with the Australian Energy Market Operator (AEMO) to provide energy and contingency frequency control ancillary services (FCAS) and operate as a VPP using Tesla's Autobidder software.

Tesla is currently progressing Phase 3A – installing 3,000 solar and Tesla Powerwall home battery systems on SAHA properties, with support from the South Australian Government, the Australian Renewable Energy Agency (ARENA) and the Clean Energy Finance Corporation (CEFC).

SAVPP Phase 3A also aims to demonstrate the technical capability of VPPs to provide reactive power voltage support, fast frequency response (FFR) and inertia. These new grid services are funded by South Australia's Grid Scale Storage Fund (GSSF).

The key findings presented in this knowledge sharing report include:

- Local insurance providers need further experience with centrally owned distributed energy assets to facilitate future VPP growth, particularly for those assets seeking bank finance;

- Preliminary findings from the voltage testing trial indicate strong performance in correcting distribution network voltages towards 230V; and

- Revenues from network services and contingency FCAS are critical in underpinning the bankability of VPPs and ensuring that VPP operators can offer competitive and attractive customer offerings. These payments form a crucial component of the commercialisation of future aggregated, active DER projects.

The GSSF funding provided to the project aims to fill a current market gap in the valuation of new system security services from VPPs. A key aim of this funding is to demonstrate the technical capability of VPPs in providing these services, establish the market value of these services, and identify customer impact in providing these services.

A particular area of knowledge sharing outlined in this first report is the work done with SA Power Networks (SAPN) on establishing a reactive power voltage support trial, whereby prototypical voltage response curves are applied to SAVPP sites according to SAPN's local network topology. This trial aims to demonstrate whether deploying a range of prototypical volt-var curves on a static basis provides enough of a benefit to the network that it can be monetised. Preliminary results are encouraging, with measurements at nominated Powerwall inverter terminals indicating strong performance in drawing voltages towards 230V.

Tesla looks forward to sharing further results and analysis on the voltage testing workplan, together with virtual inertia field trials upon release of the next Knowledge Sharing Report later in 2021, due upon the deployment of a further 1,000 systems (Milestone 3).

Insights from these trials will inform future regulatory reform across the NEM, such as the Australian Energy Market Commission's (AEMC) fast frequency response proposals, and future frameworks to value and monetise the provision of network support and inertia from distributed assets.

A suburb in Adelaide that South Australia's Virtual Plant has expanded to.

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1. Overview

1.1. About Tesla

Tesla Motors Australia, Pty Ltd (Tesla) is a global leader in manufacturing electric vehicles and clean energy products. Tesla produces a unique set of energy solutions such as Powerwall* and Megapack*, enabling homeowners, businesses, and utilities to manage renewable energy generation, storage, and consumption. Our mission is to accelerate the world's transition to sustainable energy and globally Tesla has deployed more than 6.2 GWh of residential and utility scale energy storage systems across 40 countries. In 2020 alone, Tesla deployed more than 3 GWh of energy storage systems around the world and installed its 200,000th Powerwall.

Tesla is also a leader in delivering high quality virtual power plants (VPPs). The South Australia VPP (SAVPP), delivered by Tesla and Energy Locals with support from the Government of South Australia and the Australian Renewable Energy Agency (ARENA) currently has 16 MW registered to provide all six contingency frequency services – and has been providing high quality frequency response services for almost two years.

Tesla currently employs more than 140 people in Australia to undertake the full range of the development and deployment of utility scale energy storage and VPP work. Our permanent employees provide end-to-end development of all Tesla's local energy projects including Business Development, Engineering, Project Management, Project Deployment, Software Development, Market Integration, Service & Operations.

* https://www.tesla.com/en_au/powerwall
* https://www.tesla.com/en_au/megapack

1.2. Introduction to SAVPP

The SAVPP is a globally leading project which will see the deployment of up to 50,000 solar and Tesla Powerwall home battery systems across South Australia, forming Australia's largest virtual power plant. The SAVPP leverages smart software integrated into Tesla's Powerwall, a 13.5 kWh home battery, to optimise system dispatch and market bidding. The SAVPP is designed to provide more affordable, reliable and secure electricity for all South Australians, while increasing homeowners' visibility of their energy use and supporting South Australia's transition to net zero emissions.

SA VPP is being developed in Phases:

- **Phase 1** (100 systems on South Australia Housing Authority (SAHA) properties): completed on 30 June 2018 was funded by a $2 million SA Government grant under the Renewable Technology Fund ("RTF"). This Phase demonstrated the technical capability of the systems to operate as a VPP and tested the deployment approach as well as assisting with the development of scalable deployment strategies and supporting the development of Tesla software. Phase 1 systems demonstrated for the first time the physical capability of battery assets at the household level to provide ancillary services typically provided by utility scale batteries and generators.

- **Phase 2** (1,000 systems on SAHA properties): completed December 2019 and was supported by the SA Government through a $20 million loan provided under the RTF. SAHA customers received a system at no upfront cost and a market leading retail electricity offer (for all electricity consumption, from either the grid or the system). These assets are registered with the Australian Energy Market Operator (AEMO) to provide energy and contingency FCAS and operated as a VPP using Tesla's Autobidder software.

- **Phase 3A** (3,000): With support from the Government of South Australia, the Australian Renewable Energy Agency (ARENA) and the Clean Energy Finance Corporation (CEFC) Tesla is currently progressing Phase 3A – installing an additional 3,000 solar and Tesla Powerwall home battery systems on Housing SA homes, expanding upon the 1,100 systems previously installed.

SAVPP Phase 3A aims to demonstrate the technical capability of VPPs to provide voltage support, fast frequency response (FFR) (less than 1 second response time) and inertia. This builds on the work done during Phase 2 during which the SAVPP was registered to provide contingency FCAS services in the AEMO VPP Demonstration Program[1].

The SAVPP also aims to reduce customers' energy costs by passing through energy market benefits to customers – by way of a reduced electricity retail rate. These outcomes are achieved by leveraging smart, controllable distributed energy resources (DER) to ensure systems are used to their full potential, co-optimising real-time behind the meter customer data including tariff information, solar generation, load and local conditions against energy market participation using Tesla's leading Autobidder software.

The SAVPP is the largest Tesla VPP operating globally and the first VPP to use Tesla market integration and bidding software globally. The market participation and operation aspect of the SAVPP in Australian frequency markets has provided important insights for Tesla to develop and improve aggregation and market integration software.

Tesla sees VPPs as a critical priority in our focus to transition the world to sustainable energy. Orchestration is critical to achieving this goal, as is proper market integration and the continued development of new and improved customer offerings. The lessons learnt from the work being done in SA will drive the potential growth of VPPs in both Australia and internationally.

[1] https://aemo.com.au/en/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/virtual-power-plant-vpp-demonstrations

1.3. Active vs uncontrolled distributed energy resources (DER)

VPPs are uniquely placed to deal with the unique energy market conditions in South Australia. South Australia leads the world in respect of the penetration of DER – particularly rooftop solar. More than 33% of households have solar installed, totalling more than 1,400 MW of capacity[2] – representing the largest generation asset of the state. The vast majority of this DER is uncontrolled – unable to respond dynamically to real time conditions and market signals. There are two options in how to manage these risks:

1. Force behaviour through regulated minimum performance standards or network requirements and technical specifications to govern DER behaviour under specified conditions. This approach risks limits DER functionality and consumer uptake.

2. Encourage behaviour through market frameworks, incentivising DER to respond to market signals at all times. This approach protects consumer interests and maximises uptake of controllable DER.

Tesla views active, controllable DER, such as VPPs as a way forward in managing system security risks, while opening up new opportunities for customers, networks, retailers and the market operator. Tesla currently has 16 MW of controllable distributed generation and load registered with AEMO under the SAVPP. To help SA accelerate its transition to low emissions, low cost and secure energy, we will continue to work on the following critical areas, explained in more detail below.

[2] https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/sa_advisory/2020/2020-south-australian-electricity-report.pdf?la=en

1.4. Environmental benefits of VPPs

An additional benefit of VPPs is their capability to reduce emissions from electricity generation in the NEM. The combined yearly impact of all 4,000 SAVPP sites installed under Phase 1, 2 and 3A amounts to an indicative reduction in emissions of 11,900 tonnes of CO2-e per year[3].

Tesla Powerwall is the battery hardware used in the program.

[3] Calculated using average SAVPP solar generation data per of 6,920kWh per site per year, average yearly electricity consumption in South Australian homes of 4,950kWh (see https://www.aer.gov.au/system/files/Residential%20energy%20consumption%20benchmarks%20-%209%20December%202020_0.pdf) and a scope 2 emissions factor of 0.43kg CO2-e/kWh for the South Australian grid from 2020 National Greenhouse Accounts Factor data (see: https://www.industry.gov.au/sites/default/files/2020-10/national-greenhouse-accounts-factors-2020.pdf). These calculations do not account for losses. In reality VPPs would likely reduce emissions further due to displacing peaking capacity which is often more emissions intensive than average generation.

2. Project Lessons Learnt

2.1. Financing VPPs

The SAVPP is the first VPP to secure bank financing from the CEFC, requiring an extra degree of due diligence to allow the project to reach financial close. Critical to this process was having the project insured in order to satisfy the CEFC's lending requirements, and to make the project financially viable.

A particular challenge encountered during contractual negotiations was the issue of insurance. Residential solar and storage systems tend to be captured under home and contents insurance in Australia. Compared to the US market, where there is a well-established residential power purchase agreement (PPA) market, Australian insurers are not used to providing insurance to third parties that own distributed renewable assets that are geographically dispersed.

In order to procure insurance, Tesla initially sought offerings from local markets. Given the nascent nature of this offering in Australia currently, there was very little interest from major insurers in providing the appropriate cover.

Local insurers' appetite for risk was further dampened in the wake of bushfires, droughts and COVID, forcing Tesla to consider importing a global insurance solution, and leveraging market insights from the US, where PPA markets and third party ownership of DER is more established. Tesla engaged a global insurance provider for the SAVPP. The risk appetite of local insurers to provide coverage for third party owned DER is an area that needs to be addressed if new VPP business models are to succeed.

2.2. Deployment

Experience gained during Phase 2, under which Tesla deployed 1,000 solar and Powerwall systems have assisted in building the capabilities to deploy Phase 3A. To date, Tesla has now deployed 500 solar and Powerwall systems under Phase 3A, with a further 2,500 installations due to be completed and a goal to eventually expand to 50,000 systems under the SAVPP. The learnings from the deployment process will allow Tesla to scale up significantly over the coming months and years as SAVPP grows and Tesla looks to expand its VPP offerings across the NEM and worldwide.

2.3. Retail signups

SAVPP, being a retail energy plan as well as a hardware installation program is contingent on retail signups to lead deployment of systems. These retail signups are reliant on appropriate housing stock being provided to Tesla by South Australia Housing Authority (SAHA). This has involved signing up large quantities of customers to Energy Locals as their electricity retailer. Earning the trust of eligible residents for the SAVPP has been a crucial step in this process.

In collaboration with Energy Locals we tested and refined the retail signup process to maximise the customer experience. We found upfront education to be key in addressing customer concerns, ensuring successful signups and customer retention. This ensures customers can receive the best possible experience with maximum understanding of the SAVPP program. These process improvements have seen levels of weekly retail customer signups increase steadily, enabling a smooth installation process.

2.4. Group metering

An emerging deployment challenge for the SAVPP Phase 3A has been an increase in the number of sites that have group metering - a shared electricity metering configuration common in multi-tenant dwellings to maximise space and cost efficiencies. Making group metering sites eligible for installation would require installing and replacing electricity meters for every site, which would make them economically unviable.

3. Grid Scale Storage Fund (GSSF) Lessons Learnt

South Australia's GSSF has played a key role in facilitating the SAVPP's demonstration of several system security services in-market, while monetisation pathways within existing market frameworks, such as those being considered by the Energy Security Board[4] are developed. As seen in table 1 below, there are several services which VPPs can provide on a physical basis, however are precluded from doing so under the current rules.

Through the GSSF, the SAVPP will trial distributed provision of inertia, distributed reactive power voltage support and FFR to demonstrate the capability of distributed assets to provide services typically supplied by synchronous machines and utility scale generators.

[4] https://esb-post2025-market-design.aemc.gov.au/#message3

Table 1: The Grid Scale Storage Fund has enabled the distributed provision of inertia, voltage support and fast frequency response from VPPs in a world first demonstration

	Service	VPP — Current Rules	VPP — AEMO Demonstration	SA Grid Scale Storage Fund
Market Services	Energy	✓	✓	
	Regulation FCAS	✗	✗	
	Contingency FCAS – 6 second	✗	✓	
	Contingency FCAS – 60 second	✓	✓	
	Contingency FCAS – 5 minute	✓	✓	
Out of Market Demonstrations	Inertia			✓
	Voltage Support Services			✓
	Fast Frequency Response			✓

3.1. Voltage testing

Under SAVPP Phase 3A, Tesla has been conducting preliminary trials of prototypical volt-var inverter settings in conjunction with SA Power Networks (SAPN). Under this trial, five unique volt-var curves are applied to SAVPP fleet sites based on SAPN network topology, testing stricter settings than those stipulated in SAPN's TS129 connection guidelines. These curves have been deployed to all SAVPP Phase 2 sites to date, with further expansions planned over the coming months.

In collaboration with SAPN, this trial will allow Tesla to better understand the effectiveness of inverter control in providing localised voltage support and improving network voltage. This trial can help support network service providers to understand how system level voltage curves are helpful to network infrastructure.
Tesla's voltage testing work benefits from the development

of the application programming interface (API) infrastructure established by SAPN in their ARENA funded Advanced VPP Integration project[5]. Under this trial, Tesla collaborated with SAPN to establish the boundaries for VPP inverter output and behaviour in a dynamic operating envelope environment, enabling SAPN's networks to host DER at higher levels of penetration using dynamic, locational export limits rather than standard fixed per-customer export limits[6]. Through the GSSF voltage trial, Tesla and SAPN have expanded upon the data points used in previous trials, including items such as Powerwall inverter reactive power output and feeder level voltage data.

The new curves, illustrated below in Figure 1 are stricter than the standard droop curve in SAPN's TS129 connection guidelines in terms of the stipulated reactive power response required by Powerwall inverters under various network voltage conditions. Curve C represents the most aggressive curve, requiring up to 100% of Powerwall's output at times – effectively requiring all other inverter functions to cease when measured voltages exceed defined bands.

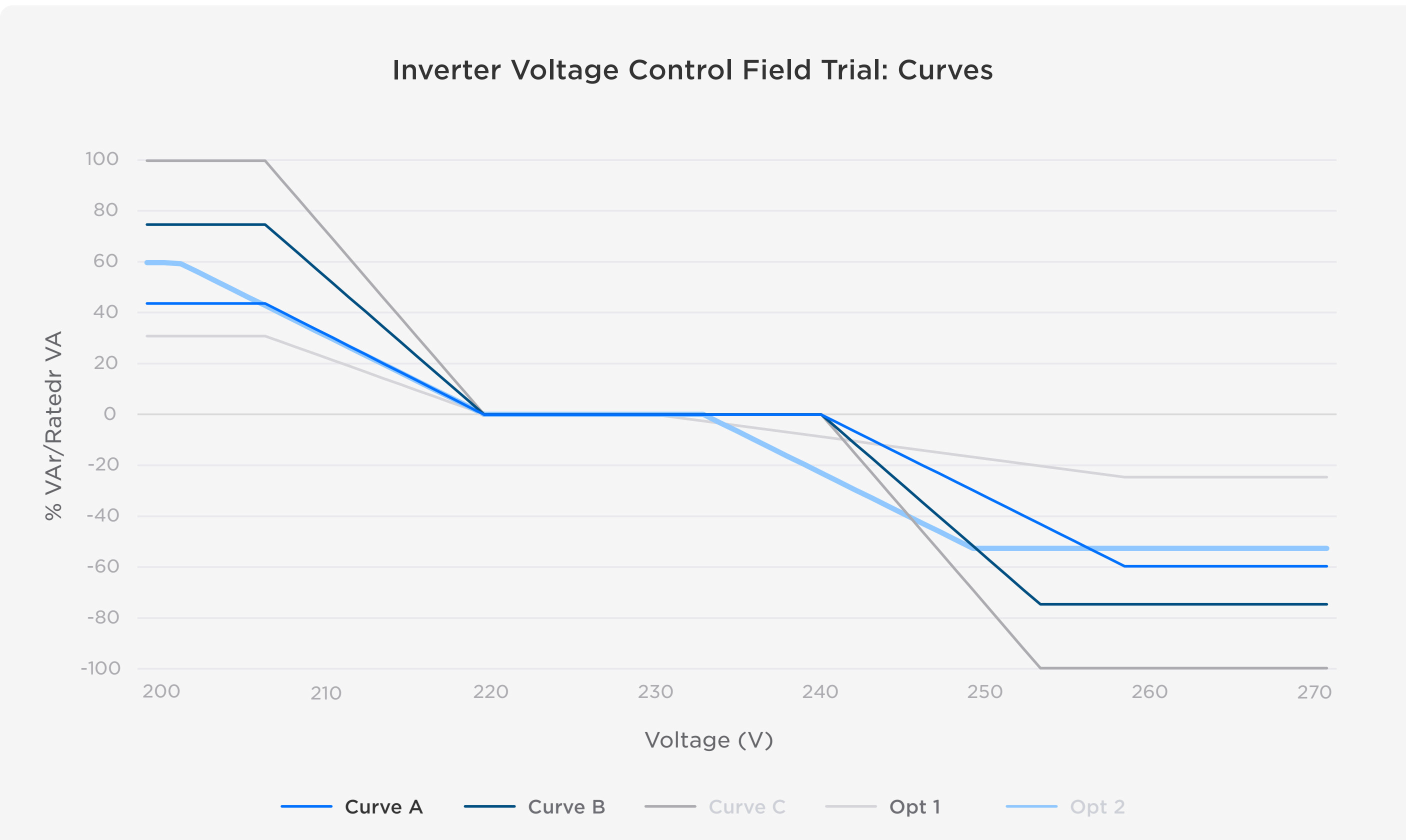

Figure 1: Prototypical voltage control droop curves being tested under SAVPP Phase 3A, against the standard droop curve in SAPN's TS129 connection guidelines

[5] https://arena.gov.au/assets/2020/09/advanced-vpp-grid-integration-detailed-technical-description-of-api-implementation.pdf
[6] https://arena.gov.au/assets/2021/01/analysis-of-the-vpp-dynamic-network-constraint-management.pdf

When needed, Tesla's inverters prioritise the provision of volt-var response as a primary response, above all other services – customer self-consumption, FCAS, virtual inertia and wholesale market participation. When a Powerwall is providing this service, its capability to serve those other interests are curtailed, which may incur an opportunity cost. As a VPP operator we are trying to measure and understand the cost/benefit trade-off of such aggressive curves.

3.2. Voltage testing results

In February 2021, Tesla and SAPN conducted notch testing on select Powerwall sites, with several volt-var curves applied to a selection of SAVPP sites in areas designated as medium residential. The following settings were trialled:

1. No volt-var response
2. SAPN's TS129 voltage droop curve
3. Custom voltage droop curve (curve B)

As seen in Figure 2 below, preliminary results thus far from the trials have been encouraging. Where custom volt-var settings were applied, measured voltages at nominated Powerwall inverter terminals indicated strong performance, drawing voltages closer to the desired voltage deadband of 230V +/-10% in comparison to other modes.

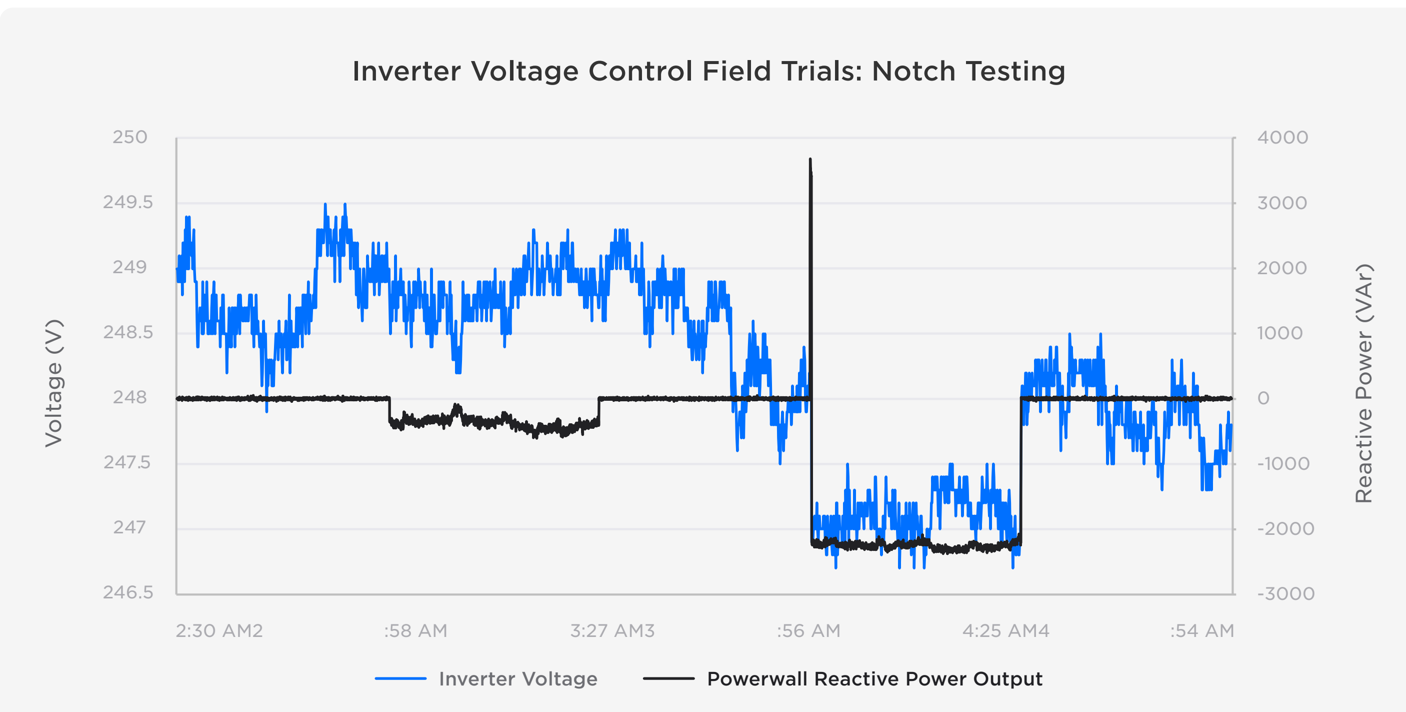

Figure 2: Measured voltages from a Powerwall test site indicates strong results from aggressive droop curve in pulling voltage towards deadband as compared to standard TS129 curve and no curve at all.

During the configuration change of the inverter, a very brief spike of reactive power occurred. It was so brief that it had no influence on inverter voltage and was only recorded due to the increased logging frequency set for these sites. This scenario will not apply in real world conditions as volt-var settings are usually set and forget and not suddenly changing such as in this notch test.

Measured voltages at the feeder level have thus far been inconclusive due to limited sample sizes, with further testing to commence in the coming months as settings are expanded to more sites.

This testing will enable greater insight into Powerwall performance under different conditions, such as different urban zones and their corresponding voltage curves. This analysis will also allow us to further explore the interplay between the provision of dynamic voltage support and wider grid support, as well as opportunity costs for consumers. Notch testing at these expanded sites will enable more robust data analysis and inform the findings of future knowledge sharing reports.

3.3. Monetisation of services

There is no pre-existing framework within the National Energy Rules to measure, value and reward network services such as voltage support from orchestrated DER. Tesla has received funding through SA's Grid Scale Storage Fund (GSSF) to reward dynamic voltage curves, allowing demonstration of advanced volt-var inverter control capabilities in-market.

The key findings that Tesla expects to see over the course of the ARENA project is whether deploying a range of prototypical volt-var curves on a static basis provides enough of a benefit to the network that it can be monetised. Similarly we expect to be able to assess whether this value outweighs any opportunity cost that comes with reduced self-consumption or constrained market activity.

These findings will help inform future regulatory reform, unlocking the capabilities of active DER in providing support to distribution network infrastructure through a structured framework – giving VPPs a new, important revenue stream and allowing further expansion.

3.4. Value of network services for VPPs

VPPs will play an increasingly important role in supporting network infrastructure as penetrations of DER increase. Payments to VPPs from network service providers (or in this case, from the GSSF) for the provision of network services are critical in underpinning the bankability of VPPs and ensuring that VPP operators can offer competitive and attractive customer offerings. This is particularly important for VPP operators seeking bank finance such as from the CEFC.

The funding provided by the GSSF constitutes a significant proportion of the SAVPP's revenues. This funding underpins the viability of the SAVPP and demonstrates the critical importance of network services payments to ensure the project's bankability.

Tesla Powerwall stores excess solar, making it available at night or during an outage.

3.5. Fast frequency response trials

All SAVPP Phase 2 sites are currently providing fast frequency response (FFR) (less than one second response time). Additionally, 10 sites have high speed logging activated, capturing data at 100 milliseconds resolution in order to measure SAVPP fleet response times to contingency events. As seen in Figure 3 below, in May 2021 following an explosion at the Callide C coal plant, registered SAVPP sites responded by providing a 16 MW-equivalent fast frequency response active power injection within one second, helping to restore the energy system to a safe operating state.

Figure 3 provides an example of the SAVPP responding to the major contingency event caused by the Callide C explosion on the 25 May 2021.

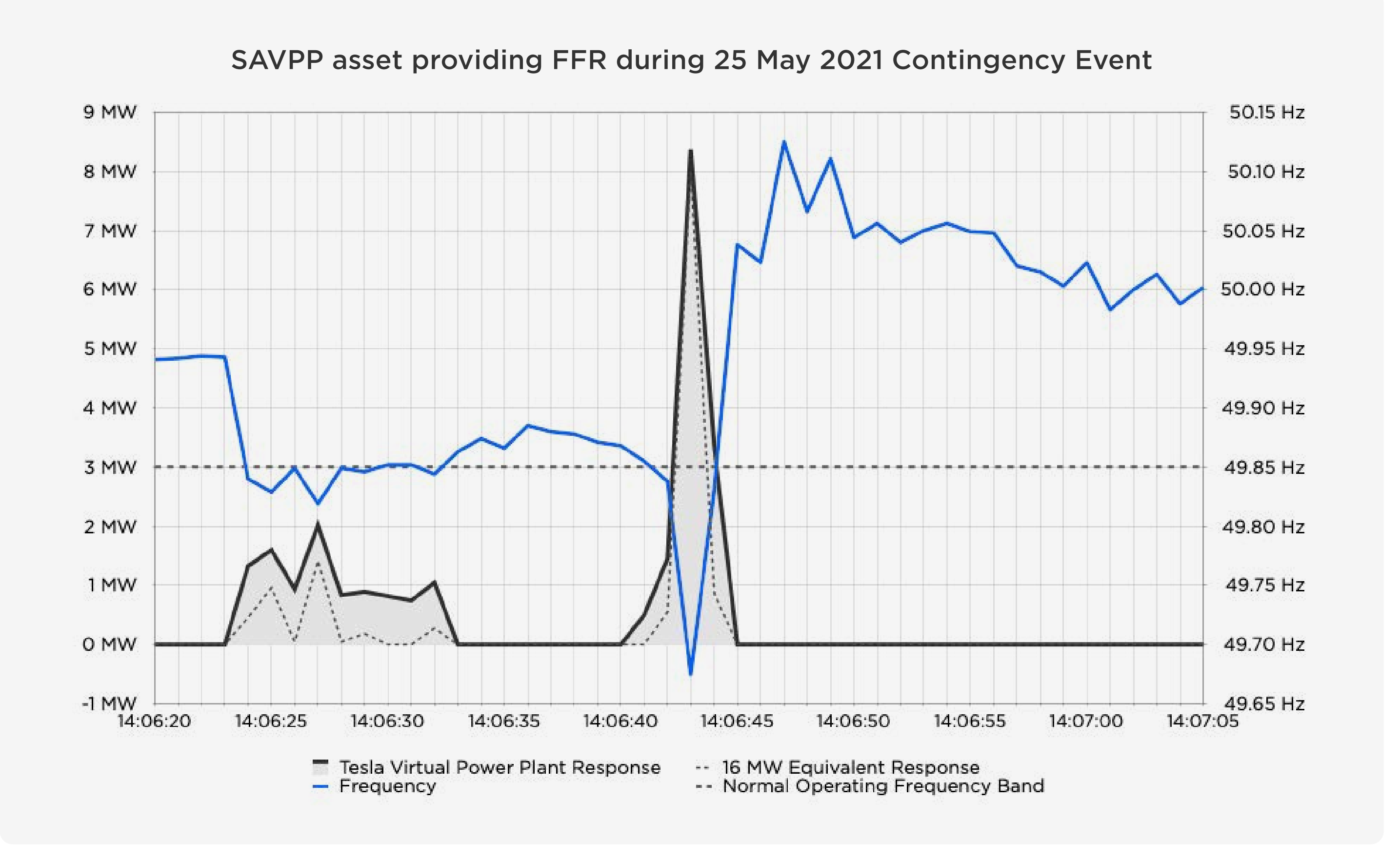

Figure 3: This example SAVPP site successfully provided a fast frequency response following the Callide C contingency event – supplying a 16 MW-equivalent response, in line with the 0.7% droop curve for VPPs.

3.6. Market Ancillary Service Specification (MASS) review

Though the technical capability of VPPs to provide FCAS is now well established[7], in order for the SAVPP to continue supplying FCAS the interim arrangements from AEMO's VPP Demonstrations program (or some variation of those arrangements) will need to be codified through AEMO's Market Ancillary Service Specification (MASS) review. Current arrangements allow SAVPP sites and other DER systems to participate in contingency FCAS markets and are critical in driving the commercial aspect of the project. This review will be critical for the future of VPPs in the NEM in facilitating the continued delivery of high quality and precise frequency control services, increasing competition and enabling VPP operators to continue delivering attractive customer offerings and make ongoing investments that support the Energy markets transition to sustainable energy. The MASS Draft Determination, however, has suggested retaining the existing MASS requirements, rather than adopting the DER settings demonstrated during the VPP Demonstrations trial. This will lead to reduced overall revenue for VPPs and DER aggregators.

There are other major benefits associated with operating systems under VPP type arrangements – as opposed to having all systems operate as passive DER. As demonstrated through the AEMO VPP trial, having VPP operators provide asset and fleet level datasets is incredibly valuable in providing distribution level visibility that otherwise does not exist to AEMO. Some NSPs are looking at also working with VPP operators to access this data to gain further insights into faults and potential risks across their distribution network.

In addition, operating systems under a VPP arrangement provides a centralised point of control that is valuable for AEMO and the networks. This provides scope to include additional market services and for aggregators to remotely respond to emerging network and system security requirements, as well as incentivising charging and discharging behaviour to manage negative load issues in the middle of the day.

[7] See AEMO's VPP Demonstrations Program Knowledge Sharing Reports 1, 2 and 3:
https://arena.gov.au/knowledge-bank/?keywords=AEMO+Virtual+Power+Plant+Demonstrations

In the absence of appropriate market access, there does not appear to be any incentives for customers to participate under VPP arrangements and provide additional system control.

3.7. Future development

A future service to be provided by the SAVPP under the GSSF will be inertia. This project will demonstrate the capability of VPPs to provide inertia services, paving the way for potential regulatory reforms and revenue streams to incentivise further battery deployment into the future. Additionally, this will be the first time that virtual inertia has been demonstrated by DER – proving the case that DER can bolster system security if in a high renewables-grid.

The results of virtual inertia tests will be shared in subsequent knowledge sharing reports.

3.8. Regulatory roadmap

There are several potential regulatory changes which may influence future commercial and operational aspects of the SAVPP and other VPPs. Results and analysis emerging from SAVPP Phase 3A trials will provide valuable in-market information to inform these developments, while ensuring that VPPs can access new markets.

These include the following programs:

- The introduction of a new FFR ancillary services market[8], led by the AEMC.

- The introduction of a new inertia market, led by the ESB[9], to value the supply of inertia as synchronous generators retire and scale down their operations.

- AEMO's MASS review[10], which will determine how VPPs can participate in FCAS markets.

[8] https://www.aemc.gov.au/rule-changes/fast-frequency-response-market-ancillary-service
[9] https://esb-post2025-market-design.aemc.gov.au/#message2
[10] https://aemo.com.au/en/consultations/current-and-closed-consultations/mass-consultation

• A push towards mandating flexible exports (or dynamic operating envelopes) for DERs[11], which may have implications for supply of FCAS by VPPs.

• The AEMC's proposed network access and pricing reforms[12], which may have implications for feed in tariffs and the economics of DER.

• The new AS4777.2: 2020 standard[13], which will more tightly govern inverters' volt-var response.

• The Project EDGE[14] partnership between AusNet, Mondo and AEMO which seeks to demonstrate integration of DER into wholesale markets while compensating DERs for network support services.

• The ESB's various other reform workstreams concerning DERs, such as Demand Side Participation[15].

4. Conclusion

Tesla is committed to maintaining our position as a technical leader in developing and delivering innovative VPP market solutions and new customer offerings. To this end, we intend to continue delivering innovating services and models to demonstrate the capabilities of VPPs to facilitate low cost, secure, reliable and emissions free electricity. And we will continue to apply the learnings from the SAVPP to advocate for the appropriate regulatory and market arrangements to enable VPPs to scale.

[11] https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/dynamic-operating-envelopes-workstream/
[12] https://www.aemc.gov.au/rule-changes/access-pricing-and-incentive-arrangements-distributed-energy-resources
[13] https://aemo.com.au/en/initiatives/major-programs/nem-distributed-energy-resources-der-program/standards-and-connections/as-nzs-4777-2-inverter-requirements-standard
[14] https://aemo.com.au/en/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/project-edge
[15] https://esb-post2025-market-design.aemc.gov.au/#message3